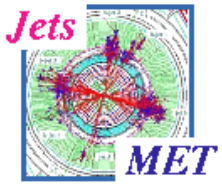
HIGH-LUMI SUSY TRIGGER



S. Abdullin

Preamble

- **Low luminosity study** : CMS IN-2002/036

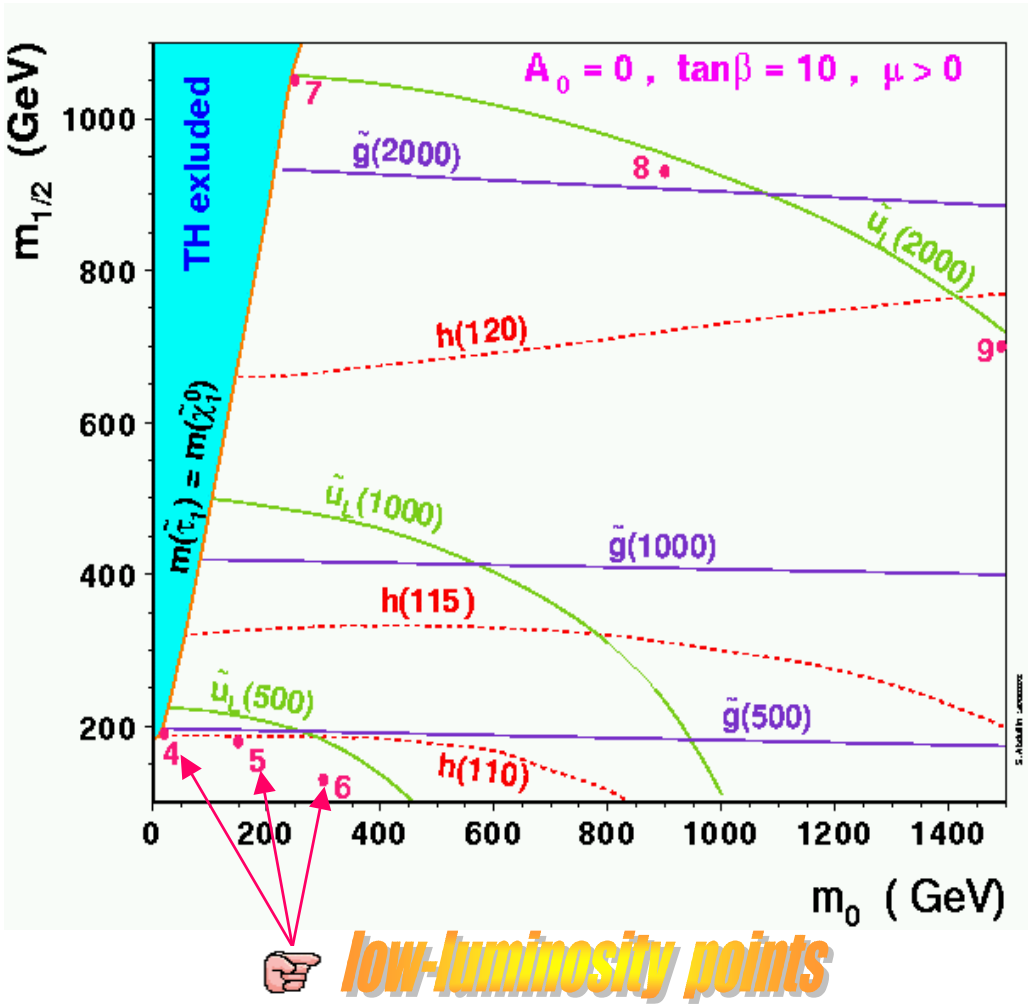
  http://cmsdoc.cern.ch/~abdullin/events/talks/acat2002.pdf

  - Probing points studied at the Tevatron II reach limit
    (along squark isomass curve of ≈ 400 GeV)
  - Given 2 kHz @ L1 and 3Hz @ L2
  - Hybrid genetic algorithm written for cuts optimization
  - 6 essential combinations of L1 and L2 channels (out of 18)
  - R-parity violation scenario yields marginal efficiency @ L2

- **Now next step - high luminosity**

  - Probing points chosen at mass scale of ≈ 2 TeV

Probing Points



$m(\tilde{\chi}_1^0) = 445$ GeV $m(h) = 122$ GeV

$m(\tilde{g}) = 2235$ GeV $m(\tilde{u}_L) = 1986$ GeV

$\sigma \sim 17$ fb tau and sneutrino – enriched

7 **250,1050**

$m(\tilde{\chi}_1^0) = 391$ GeV $m(h) = 121$ GeV

$m(\tilde{g}) = 2032$ GeV $m(\tilde{u}_L) = 1962$ GeV

$\sigma \sim 22$ fb "spoiling" dcays of chargino–neutralino

8 **900,930**

$m(\tilde{\chi}_1^0) = 293$ GeV $m(h) = 120$ GeV

$m(\tilde{g}) = 1625$ GeV $m(\tilde{u}_L) = 1975$ GeV

$\sigma \sim 59$ fb more jets, less MET

9 **1500,700**

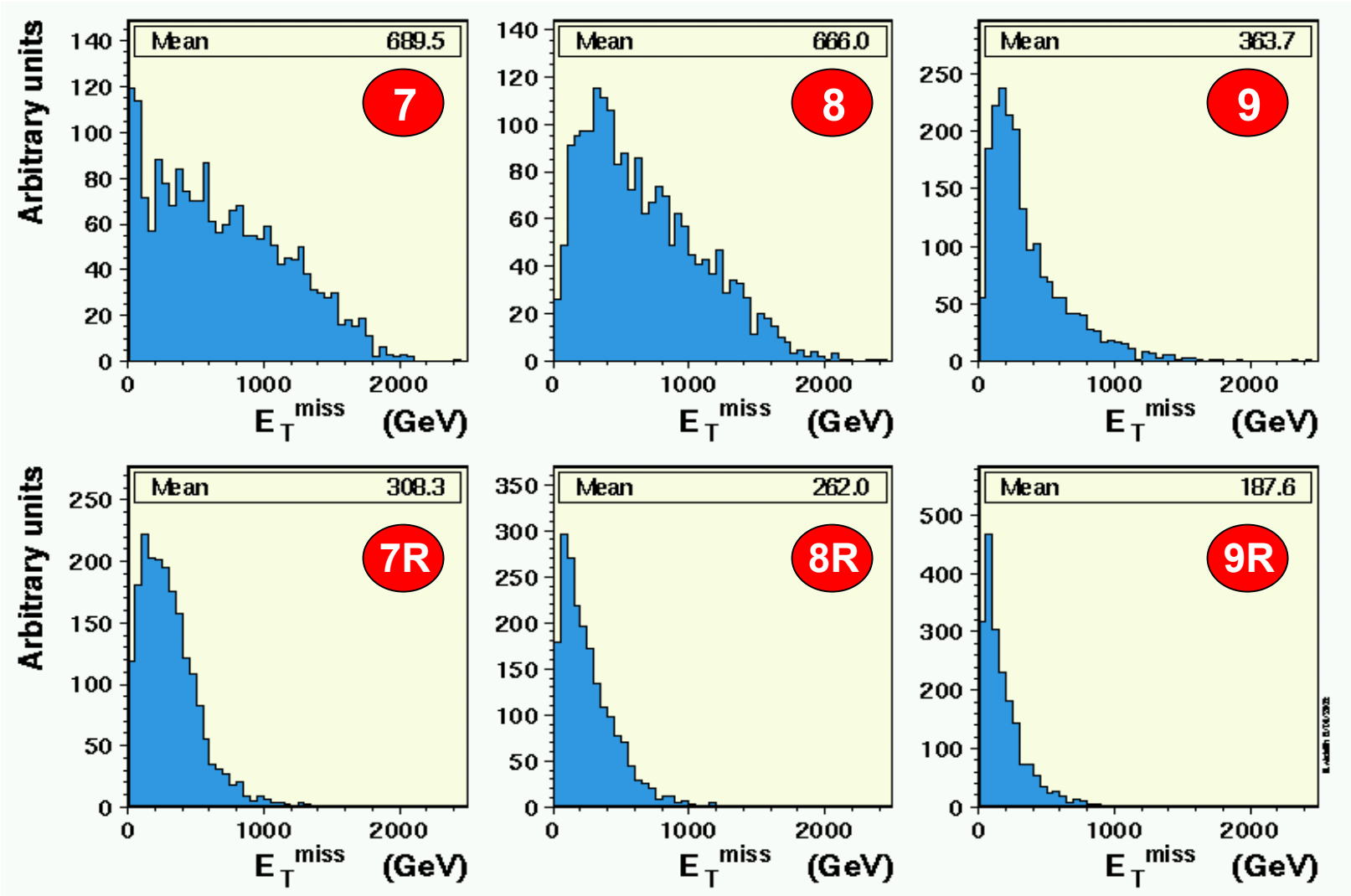
R-Parity Violation

- **Most challenging scenario (?)**
  - $\tilde{\chi}_1^0 \rightarrow$ 3 quarks
  - 6 additional jets, not necessarily soft :
    $\tilde{\chi}_1^0$ mass $\approx$ 300-450 GeV
  - Missing ET shrinks, still some amount remains
    - copious b-jets, W/Z, taus and neutralinos

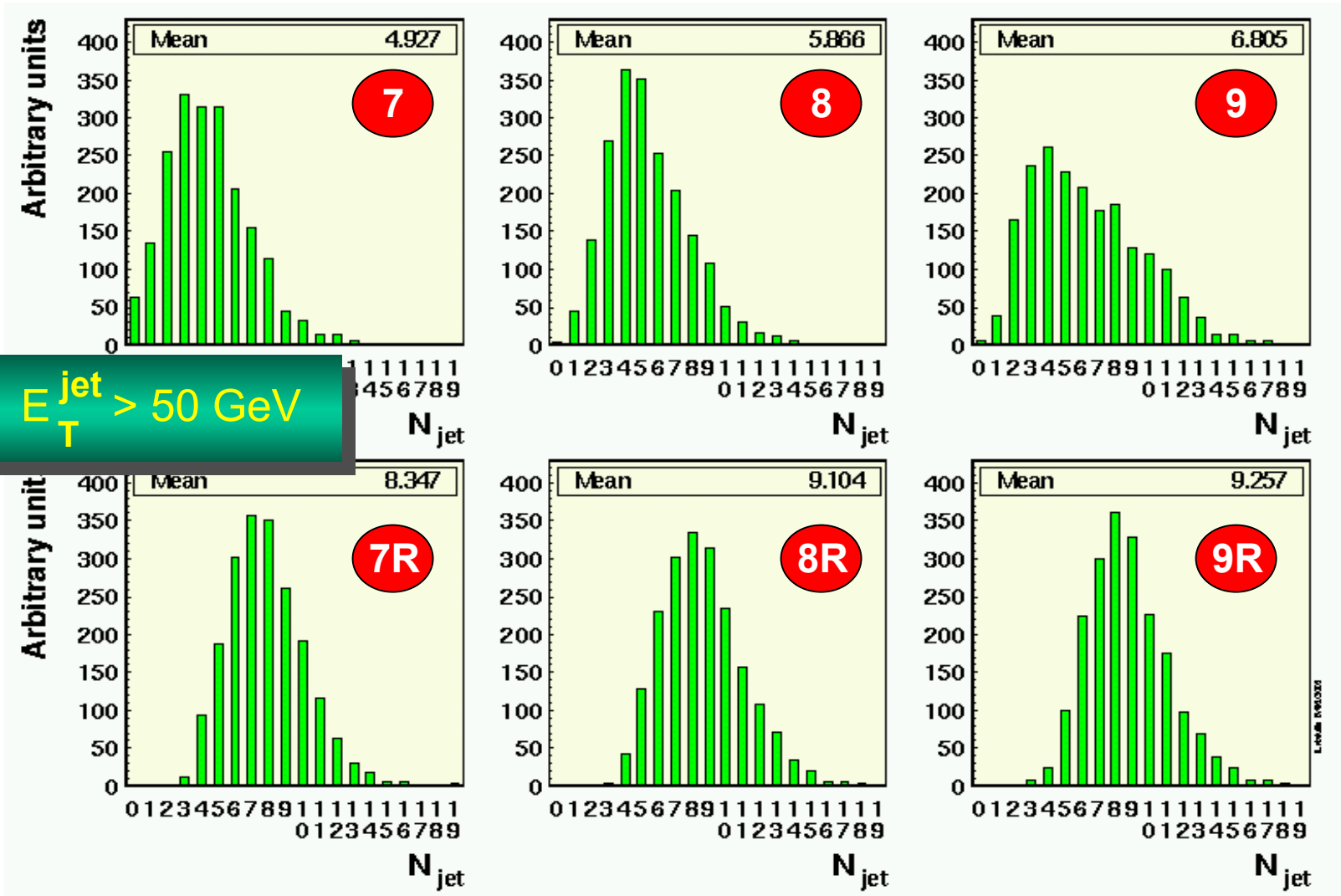
- **ISAJET 7.58 – ISAWIG 1.104 – HERWIG 6.301**

  Points 7R 8R 9R

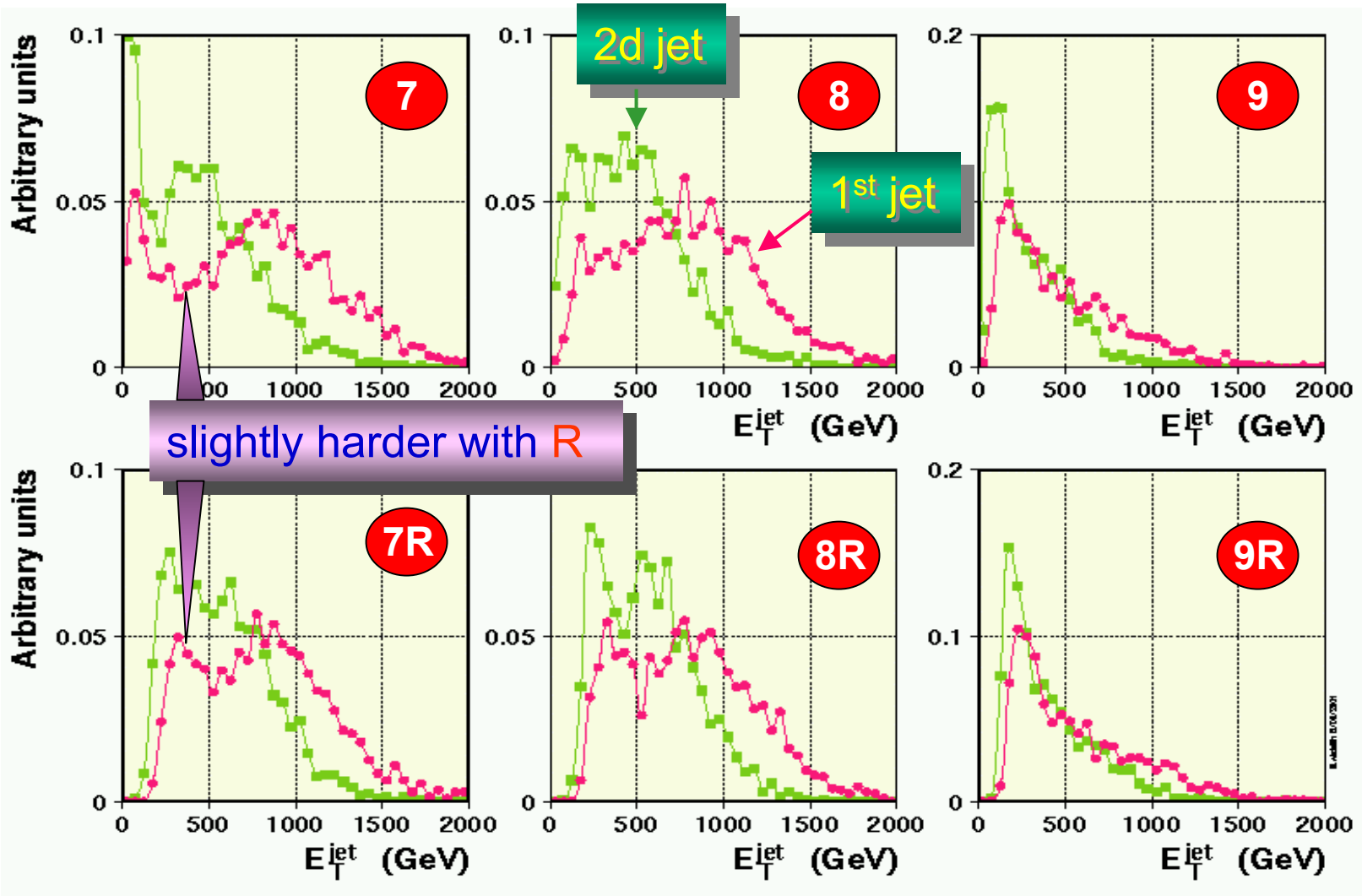
Missing ET @ L2



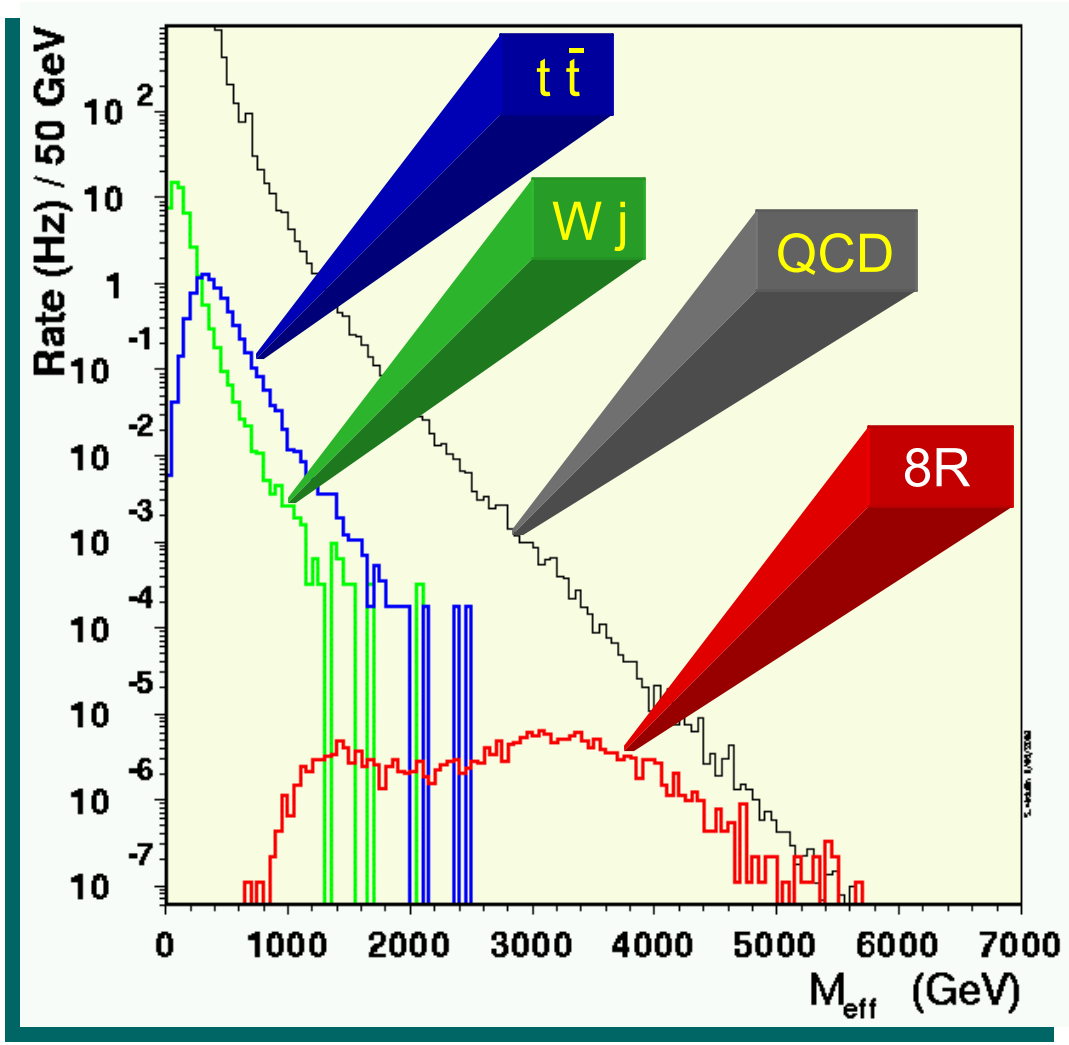
Number of Jets @ L2



Leading Jets @ L2



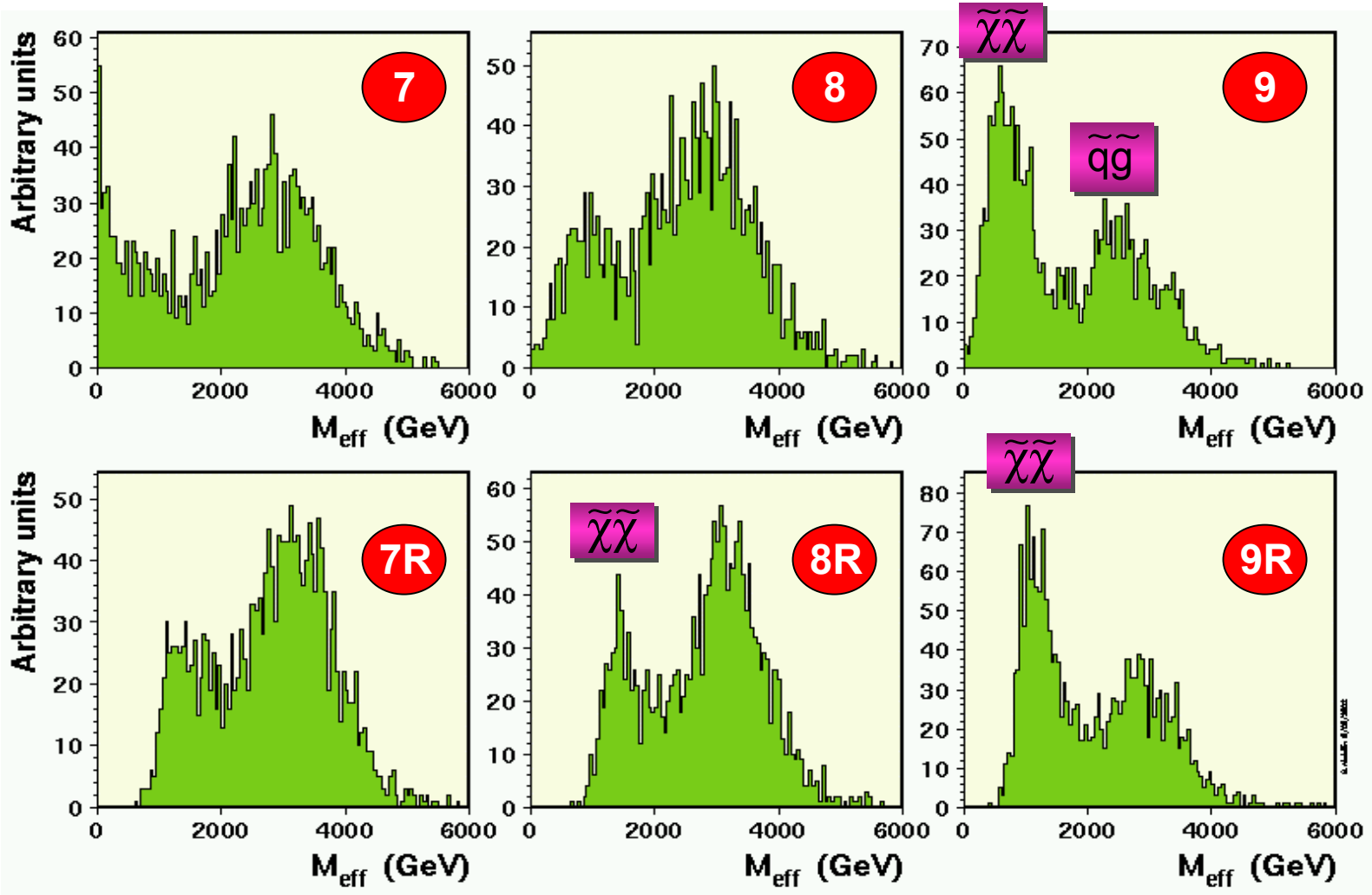
Transverse Mass @ L2



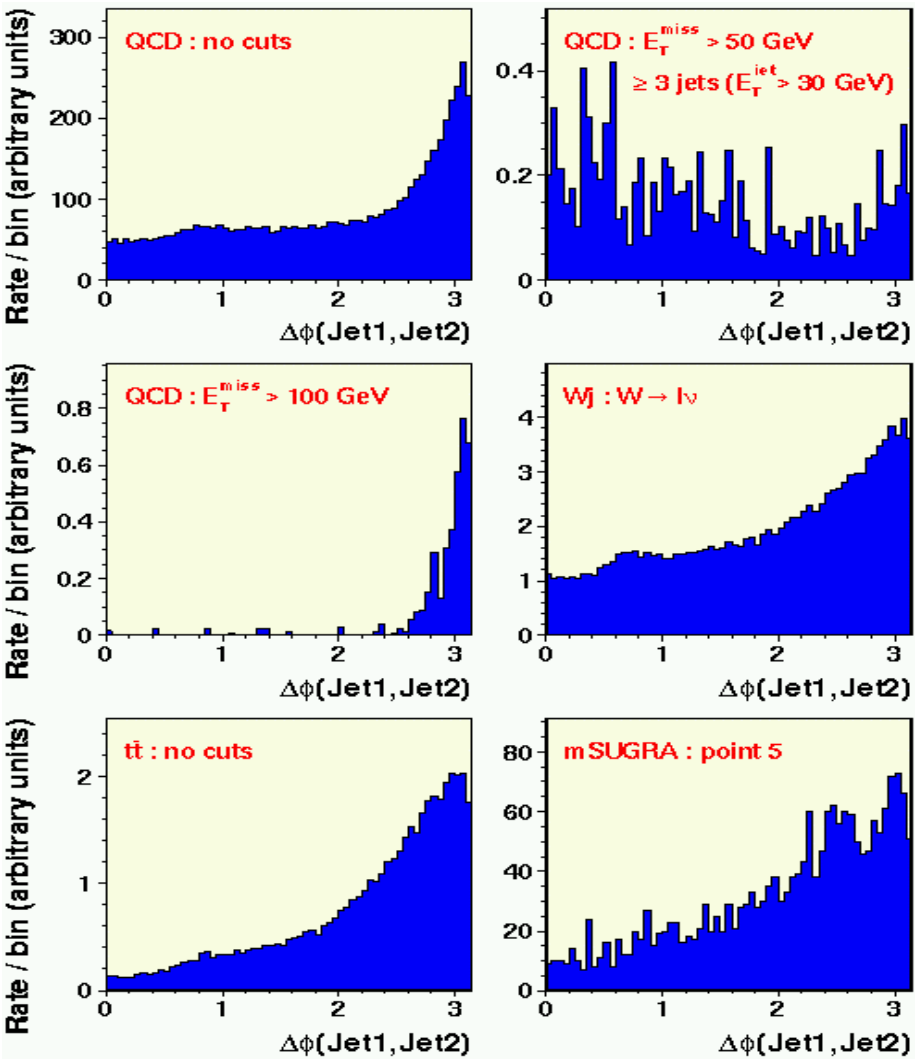
$$M = \Sigma E_T^{jet} + E_T^{miss}$$

Might be useful @ L2

SUSY Transverse Mass @ L2



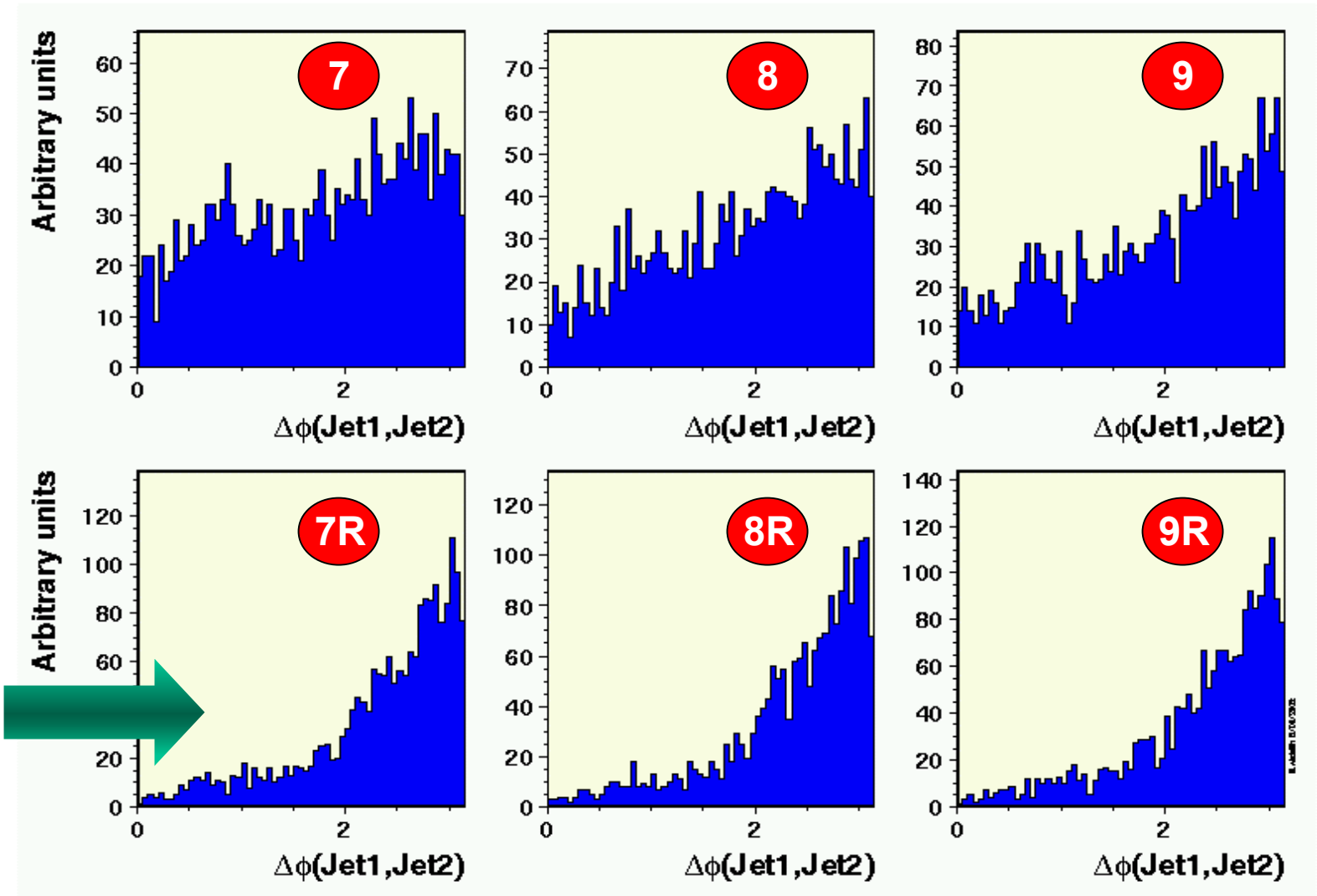
Azimuthal Angle between Leading Jets



Might be useful if the signal is flat enough…

Not for broken R-parity though …

$\Delta\phi$ (J1,J2)



Data Samples

- **6 mSUGRA samples**
  - Spring 2002 production
  - 2000 events each
  - high-lumi provisional energy corrections from Andrei Krokhotine

- **3 SM backgrounds**
  - Autumn 2001 production (low lumi !)
  - QCD (Pal's filter applied) ≈ 1 mln. events
  - Wj ($W \rightarrow l\,\nu$) ≈ 150,000 ev.
  - $t\,\bar{t}$ ≈ 46,000 ev.
  - Low-lumi jet energy corrections

L1 and L2 cuts

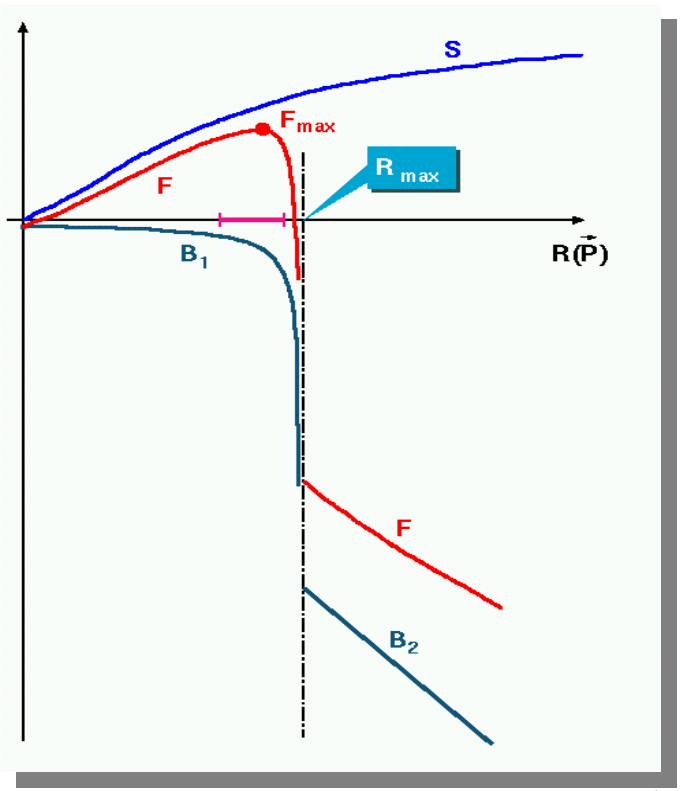
- **L1 cuts :**
  - MET || J1 || J2 || J3 || J4 || (J1 && MET)

- **L2 cuts :**
  - {(J1 && MET) || (J2 && MET) || (J3 && MET) || (J4 && MET) || Meff || MET } ||
    {
    {(J1 && MET) || (J2 && MET) || (J3 && MET) || (J4 && MET) || Meff || MET } && $\Delta\phi$(J1,J2)
    }

Hybrid Genetic Algorithm (I)

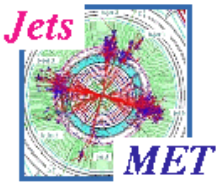
"Society of individuals

- Fixed-size population (100-1000 individuals)
- Each individual has a unique combination of genes (cuts) $\vec{P}$
- Hierarchy is established according to evaluation function $F(\vec{P})$



- Maximal signal efficiency $S(\vec{P})$
- Rate $R(\vec{P})$ is close to R_{max}

Hybrid Genetic Algorithm (II)



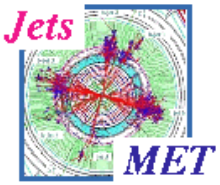
- **Act of Creation (random)**
- **Breeding**
  - random ("uniform") crossover of genes between parents, offspring is added, parents retained;
  - probability to participate ~ place in the hierarchy.
- **Mutation**
  - random change by one bit (up/down) of a random gene; mutation probability is significant (10-100 %) and independent from hierarchy;
  - Initial individual retained, the result of mutation added.
- **Selection**
  - removal of clones (repl. with newly created individ.);
  - descending ordering according to the evaluation func.;
  - removal of redundant individuals;
  - separate "Top 10" list update (if any);
- **Cataclysmic update**
  - complete random renewal of the population, except the best individual; "Top 10" is not affected also.
  - applied in case of stagnation (50-100 generations) a few times.

L1 Preliminary Results

Jets and missing E_T cuts (GeV) for optimal signal effficiency @ L1

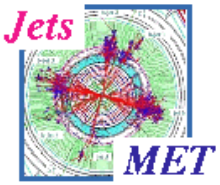
		J1	J3	J1 + MET
Cuts (GeV) →		230	80	70 + 70
signal efficiency (%)	Point 7	83 (83)	85 (62)	91 (90)
	Point 8	91 (91)	94 (76)	98 (97)
	Point 9	71 (71)	79 (67)	94 (90)
	Point 7R	98 (98)	100 (99)	100 (91)
	Point 8R	97 (97)	100 (100)	100 (86)
	Point 9R	85 (85)	99 (99)	100 (74)
Background rate (kHz)	QCD	0.53 (0.53)	1.35 (0.98)	1.98 (0.76)
	$t\bar{t}$, W j ($l\nu$)	irrelevant !		

L2 Preliminary Results



		J1&&MET		J3&&MET		J4&&MET		M_{eff}	J1&&MET&&Δϕ		
		120	400	180	240	50	120	1500	90	160	160 deg.
Signal efficiency w.r.t L1 (%)	7	73 (73)		78 (42)		86 (64)		89 (83)	95 (81)		
	8	67 (67)		75 (49)		89 (75)		91 (83)	96 (78)		
	9	35 (35)		45 (34)		74 (73)		79 (61)	89 (67)		
	7R	27 (27)		53 (51)		81 (80)		97 (92)	97 (53)		
	8R	21 (21)		42 (42)		71 (71)		96 (84)	96 (44)		
	9R	11 (11)		25 (24)		55 (55)		81 (74)	81 (31)		
Rate (Hz)	QCD	0.01		0.04(0.03)		1.17(1.15)		2.42(1.45)	2.50(0.22)		
	W j								0.18		2.9
	$t\bar{t}$								0.22		

SUMMARY



- High-mass SUSY points considered
  - Both with/without R-parity violation
  - High luminosity required …
- Cuts are optimized with genetic algorithm
- @L1 a few simple cuts do the job
- @L2 signal efficiency is (sufficiently) high …
  - Single jets cuts and MET are less effective than jet&&MET and effective transv.mass M_{eff}
- Partial L1+L2 channel-by-channel analysis to follow…